Pinpointing a disastrous limitation of Special Relativity and Proposing a new explanation for Light Speed's constancy

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Pinpointing a disastrous limitation of Special Relativity and Proposing a new explanation for Light Speed's constancy

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Abstract:

This paper pinpoints a severe infirmity of the Lorentz Transformation in the Special Theory of Relativity. Even if it were true, its ambit is very much limited. Out of infinite events happening in the universe, it covers only the events of detecting light signals at the spatial points lying on a straight line in the direction of the relative velocity between the two inertial frames. This paper points out that the slowing down of moving clocks is not a prediction of Lorentz Transformation and hints at the possibility of attributing the observed slowing down of fast-moving clocks to the Relativistic Variation of Mass with Velocity. This paper concludes that from the fact that the same Reality is perceived differently by the observers in different inertial frames, we can draw a straightforward explanation for the constancy of light's speed in all inertial frames without any need for bringing in narrow-scoped and unrealistic Lorentz Transformation.

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Section 1: Introduction

1.1.1 Relativity of Truths.

Everyone's world is their perception. Any absolute reality beyond the perceptual realities of the observers seems to be beyond the cognitive limits of human capabilities. But, fortunately for all human beings, though their perceived 'facts' may differ, the laws of Nature connecting one's perceived 'facts' are the same. A stone's trajectory dropped by a passenger in a moving train is a straight line for him, whereas it is a parabola for an observer standing on the platform. Both observers would agree that the same laws of Physics govern the physical realities perceived by them. The First Postulate of Special Relativity succinctly states this fact as follows; "The laws of nature have the same mathematical form in all inertial reference frames" **[1]**. Though the laws are the same, the scenarios of the same reality observed in different inertial frames need not be the same, as exemplified by the fact that the stone's trajectory is a straight line and a parabola in the train frame and the platform frame, respectively. This paper is a relook of Special Relativity in the Light of Perceptual Relativity, which means that the observers stationed in different inertial frames perceive the same reality differently. There is no absolute perception of that reality.

1.1.2 "Event" is more fundamental than "Time".

As there is no meaning for "**distance**" in an empty world, there is no meaning for "**Time**" in an eventless world. If the whole universe became frozen and static, Time would disappear. If a single change takes place at a point anywhere in the universe, that change

is an "**event**". The human brain has an intrinsic faculty known as "Memory", and an event 'after' it has happened becomes a memory in the human brain.

The objects are real, and the "distance" between two objects is the relation intellectually constructed by the human brain. Similarly, the events are real; the "time interval" between two events is a relation intellectually built by the human brain with the aid of its memory faculty recording events that have happened and its rational faculty to anticipate events that may occur. Distances and time come into play only to quantify the relations among the objects and events. Hence, an event is more fundamental than time. Einstein's Special Relativity, instead of sticking to events, went astray by shifting the focus on the rulers and clocks used for measuring distances and times. Events are absolute in the sense that the observers do not deny their occurrences in all inertial frames notwithstanding their differing on where and when those events happened.

Section 2: Discussion

PART – I

A serious limitation of Lorentz Transformation Equations

2.1.1 An Extract from Einstein's Original Paper

The following is an extract of a crucial part of Einstein's derivation of Lorentz Transformation Equations **[2]**:

"We now have to prove that any ray of light, measured in the moving system, is propagated with the velocity c , if, as we have assumed, this is the case in the stationary

system; for we have not as yet furnished the proof that the principle of constancy of the velocity of light is compatible with the principle of relativity.

At the time $t = \tau = 0$, when the origin of the coordinate system is common to the two systems, let a spherical wave be emitted therefrom, and propagated with the velocity $\mathbf{c}$ in system $\mathbf{K}$. If (x, y, z) be a point just attained by this wave, then

$$\mathbf{x}^2 + \mathbf{y}^2 + \mathbf{z}^2 = \mathbf{c}^2 \mathbf{t}^2.$$

Transforming the equation with the aid of our equations of transformation we obtain after a simple calculation

$$\mathbf{\epsilon}^2 + \mathbf{\eta}^2 + \mathbf{\zeta}^2 = \mathbf{c}^2 \mathbf{\tau}^2.$$

The wave under consideration is therefore no less a spherical wave with velocity of propagation $\mathbf{c}$ when viewed in the moving system. This shows that our two fundamental principles are compatible.⁵

“Footnote: 5. *The equations of Lorentz transformation may be more simply deduced directly from the condition that in virtue of those equations the relation $x^2 + y^2 + z^2 = c^2 t^2$ shall have as its consequence the second relation $\epsilon^2 + \eta^2 + \zeta^2 = c^2 \tau^2$.”*

2.1.2 Lorentz Transformation from Lorentz Invariance

Firstly, as stated in the Footnote by Einstein, let us first deduce the equations of Lorentz transformation directly from the condition that in virtue of those equations the relation $x^2 + y^2 + z^2 = c^2 t^2$ shall have as its consequence the second relation $\epsilon^2 + \eta^2 + \zeta^2 = c^2 \tau^2$.”

Let us begin with the following equations.

$$\mathbf{x}' = \mathbf{a} (\mathbf{x} - \mathbf{v}t); \quad (1)$$

$$\mathbf{y}' = \mathbf{y}; \text{ and} \quad (1a)$$

$$\mathbf{z}' = \mathbf{z} \quad (1b)$$

[For the sake of easy typing, we have used the notations $\mathbf{x}'$, $\mathbf{y}'$ and $\mathbf{z}'$ instead of $\mathbf{\hat{x}}$, $\mathbf{\hat{y}}$ and $\mathbf{\hat{z}}$, respectively. Similarly, we shall use $\mathbf{t}'$ instead of $\mathbf{\hat{t}}$.]

The factor $\mathbf{a}$ in Equation (1) is the **Lorentz Factor** commonly denoted as γ in many textbooks on Relativity. When $\mathbf{x}' = \mathbf{x} - \mathbf{a}t$ is the physical reality, the inclusion of $\mathbf{a}$, the Lorentz Factor, in the first place, is only an artificial mathematical manipulation to make the two equations $\mathbf{x}' = \mathbf{x} - \mathbf{a}t$ and $\mathbf{x} = \mathbf{x}' + \mathbf{a}t'$ identical even when $\mathbf{t} \neq \mathbf{t}'$ to account for the interchangeability of the frames demanded by the First Postulate of the Special Theory of Relativity. A mathematical consequence of such inclusion of an unrealistic factor is “**Length Contraction**”, which is the shortening of the lengths measured by the observers of one inertial frame in the perspective of the observers in other frames.

$\mathbf{x} - \mathbf{x}'/\mathbf{a} = \mathbf{v}t$, from the perspective of the unprimed frame, and

$\mathbf{x}/\mathbf{a} - \mathbf{x}' = \mathbf{v}t'$ from the perspective of the unprimed frame

which, in turn, led to “**Time Dilation**”, which is the shortening of the time intervals measured by the observers of one inertial frame in the perspective of the observers in other frames

$\mathbf{x}/c - \mathbf{x}'/ac = \mathbf{vt}/c$, from the perspective of the unprimed frame, and

$\mathbf{x}/ac - \mathbf{x}'/c = \mathbf{vt}'/c$ from the perspective of the unprimed frame

when $\mathbf{x} = \mathbf{ct}$ and $\mathbf{x}' = \mathbf{ct}'$

$\mathbf{t} - \mathbf{t}'/a = \mathbf{vx}/c^2$, from the perspective of the unprimed frame, and

$\mathbf{t}/a - \mathbf{t}' = \mathbf{vx}'/c^2$ from the perspective of the unprimed frame.

Substituting (1), (1a) and (1b) in the relation $\epsilon^2 + \eta^2 + \zeta^2 = c^2 \tau^2$, that is $\mathbf{x}'^2 + \mathbf{y}'^2 + \mathbf{z}'^2 = c^2 \mathbf{t}'^2$ and equating it with the relation $\mathbf{x}^2 + \mathbf{y}^2 + \mathbf{z}^2 = c^2 \mathbf{t}^2$ in the light of Einstein's footnote (infra), we get

$$a^2(\mathbf{x} - \mathbf{vt})^2 + \mathbf{y}^2 + \mathbf{z}^2 - c^2 \mathbf{t}'^2 = \mathbf{x}^2 + \mathbf{y}^2 + \mathbf{z}^2 - c^2 \mathbf{t}^2$$

$$a^2(\mathbf{x}^2 + \mathbf{v}^2 \mathbf{t}^2 - 2\mathbf{vxt}) - c^2 \mathbf{t}'^2 = \mathbf{x}^2 - c^2 \mathbf{t}^2$$

Rearranging terms, we get

$$\mathbf{t}'^2 = [(a^2 - 1) / c^2] \mathbf{x}^2 + [(c^2 + a^2 \mathbf{v}^2) / c^2] \mathbf{t}^2 + [2a^2 \mathbf{v} / c^2] \mathbf{xt} \quad (2)$$

According to Einstein $\mathbf{t}'$ i.e., $\mathbf{\tau}$ is a linear function. His reasoning is: *“In the first place, it is clear that the equations must be linear on account of the properties of homogeneity which we attribute to space and time.”* [2]

Let us first agree with Einstein and take $\mathbf{t}'$ as a linear function in $\mathbf{x}$ and $\mathbf{t}$. [We shall later prove that $\mathbf{t}'$ is a linear function in $\mathbf{x}$ and $\mathbf{t}$ only for propagation of light along the direction of the relative velocity between the two frames.]

Taking **t'** to be a linear function in **x** and **t**

$$\mathbf{t'} = \mathbf{dx} + \mathbf{et} \quad (3)$$

where the values of the coefficients **d** and **e** have to be determined.

Squaring the Equation (3), we get

$$\mathbf{t'^2} = \mathbf{d^2x^2} + \mathbf{e^2t^2} + \mathbf{2dext} \quad (4)$$

Equating coefficients in Equations (2) and (4),

$$\mathbf{d^2} = \mathbf{[(a^2 - 1) / c^2]}$$

$$\mathbf{e^2} = \mathbf{[(c^2 + a^2v^2) / c^2]}$$

$$\mathbf{de} = \mathbf{[2a^2v / c^2]}$$

Solving the above three simultaneous equations, we get the values of **a**, **d** and **e** as follows:

$$\mathbf{a} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\mathbf{d} = \mathbf{av/c^2}$$

$$\mathbf{e} = \mathbf{a}$$

Therefore, Lorentz Transformation Equations are;

$$x' = a (x - vt) \quad (5)$$

$$t' = a (t - vx/c^2) \quad (6)$$

The Inverse Lorentz Transformation Equations are;

$$x = a (x' + vt') \quad (5a)$$

$$t = a (t' + vx'/c^2) \quad (6a)$$

where

$$a, \text{ Lorentz Factor} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

2.1.3 Proving the limitation of Lorentz Transformation

Now, we are going to prove in three **different methods** that Lorentz Invariance i.e.,

$\epsilon^2 + \dot{\eta}^2 + \zeta^2 - c^2 \tau^2 = x^2 + y^2 + z^2 - c^2 t^2$ is valid only when the direction of propagation of the ray of light is the same as the direction of the relative velocity between the two systems. In other words, if the direction of the relative velocity between the two systems is taken as **X-axis**, the equation holds good only in respect of the points lying on the **X-axis** and fails in respect of the points not lying on the **X-axis**. This means that Lorentz Transformation is valid only for $\dot{\eta} = y = 0$ and $\zeta = z = 0$

2.1.3.1 FIRST METHOD

The following Pictures give an 'assumed' scenario of an event of detection of Light at a spatial point in the **X-Y Plane** that does **Not** lie on the **X-Axis**.

FIGURE 1
The Observed Event from the perspective of the Frame S

FIGURE 2
The Observed Event from the perspective of the Frame S'

From the perspective of both **S** and **S'**.

$$\mathbf{x} = \mathbf{ct} \cos \theta \quad (7)$$

$$\mathbf{x}' = \mathbf{ct}' \cos \Phi \quad (8)$$

Substituting the above values of **x** in Lorentz Transformation Equations (5), we get

$$\begin{aligned} \mathbf{x}' &= \mathbf{a} (\mathbf{x} - \mathbf{vx} / \mathbf{c} \cos \theta) \\ &= \mathbf{a} (1 - \mathbf{v} / \mathbf{c} \cos \theta) \mathbf{x} \end{aligned} \quad (9)$$

Substituting the above values of **x'** in Lorentz Transformation Equations (5a), we get

$$\begin{aligned} \mathbf{x} &= \mathbf{a} (\mathbf{x}' + \mathbf{vx}' / \mathbf{c} \cos \theta) \\ &= \mathbf{a} (1 + \mathbf{v} / \mathbf{c} \cos \Phi) \mathbf{x}' \end{aligned} \quad (9a)$$

Substituting the value of **x'** from Equation (9) in Equation (9a),

$$\begin{aligned} \mathbf{x} &= \mathbf{a} (1 + \mathbf{v} / \mathbf{c} \cos \Phi) \mathbf{a} (1 - \mathbf{v} / \mathbf{c} \cos \theta) \mathbf{x} \\ (1 / \mathbf{a}^2) &= (1 - \mathbf{v} / \mathbf{c} \cos \theta) (1 + \mathbf{v} / \mathbf{c} \cos \Phi) \\ \text{Therefore, } (1 - \mathbf{v}^2 / \mathbf{c}^2) &= (1 - \mathbf{v} / \mathbf{c} \cos \theta) (1 + \mathbf{v} / \mathbf{c} \cos \Phi) \end{aligned} \quad (10)$$

Substituting the above values of **x** in Lorentz Transformation Equations (6), we get

$$\begin{aligned} \mathbf{t}' &= \mathbf{a} (\mathbf{t} - \mathbf{v} \mathbf{ct} \cos \theta / \mathbf{c}^2) \\ &= \mathbf{a} (1 - \mathbf{v} \cos \theta / \mathbf{c}) \mathbf{t} \end{aligned} \quad (11)$$

Substituting the above values of **x'** in Lorentz Transformation Equations (6a), we get

$$\begin{aligned} \mathbf{t} &= \mathbf{a} (\mathbf{t}' + \mathbf{v} \mathbf{ct} \cos \Phi / \mathbf{c}^2) \\ &= \mathbf{a} (1 + \mathbf{v} \cos \Phi / \mathbf{c}) \mathbf{t}' \end{aligned} \quad (11a)$$

Substituting the value of **t'** from Equation (11) in Equation (11a),

$$\mathbf{t} = \mathbf{a} (1 + \mathbf{v} \cos \Phi / \mathbf{c}) \mathbf{a} (1 - \mathbf{v} \cos \theta / \mathbf{c}) \mathbf{t}$$

$$(1/a^2) = (1 - v \cos \theta / c) (1 + v \cos \Phi / c)$$

$$\text{Therefore, } (1 - v^2/c^2) = (1 - v \cos \theta / c) (1 + v \cos \Phi / c) \quad (12)$$

For the Equations (10) and (12) to be simultaneously true

$$\cos \theta = 1 \text{ and } \cos \Phi = 1$$

This means $\theta = 0$ and $\Phi = 0$

Thus, we have proved that Lorentz Transformation is valid only when the direction of propagation of the ray of light is the same as the direction of the relative velocity between the two systems.

2.1.3.2 SECOND METHOD

We may arrive at the above conclusion in another way also.

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = x^2 + y^2 + z^2 - ct^2$$

Since $y' = y$, $z' = z$, the above identity is reduced to

$$x'^2 - c^2 t'^2 = x^2 - ct^2$$

FIGURE 3

The Detection of a Light Signal at a spatial point in X-Y plane (not on X-axis) from the perspective of the Frame S'

$$c^2 t'^2 = x'^2 + y'^2$$

$$t' = \sqrt{\frac{x'^2 + y'^2}{c^2}}$$

The expression for t' can have a linear form if and only if $y' = 0$ i.e., the point of detection of Light Signal falls on X-axis

$$t' = x' / c = a (x - vt) / c = a[(x/c) - v(x/c) / c] = a (t - vx/c^2)$$

2.1.3.3 THIRD METHOD

We may arrive at the same conclusion that Lorentz Transformation is valid only when the direction of propagation of the ray of light is the same as the direction of the relative velocity between the two systems in a third way also.

For a pair of events whose space and time distances are measured by the observers in the frames S and S' , let us define two values p and q as follows:

$$p = x/t \quad \text{and} \quad q = x'/t'$$

We shall derive **Generalized Transformation Equations** involving p and q so that that in our derived Equations, if we substitute both p and q with c we shall get the usual Lorentz Transformation Equations. In other words, $p = q = c$ is a special case of **Generalized Transformation Equations**; and this special case is **Lorentz Transformation Equations**

Let us consider two events. Let the first event be taken as the Origin Event and assigned the coordinates **(0,0)** by both frames.

Let the **space difference** and the **time difference** between the events under consideration be

pt and **t** for the frame **S** respectively; and

qt' and **t'** for the frame **S'** respectively.

The following figure depicts the scenario of the second event **E** from the perspective of the frame **S**,

FIGURE 4

**Scenario of the Second Event from the perspective of Frame S.
(O at rest; O' has moved the distance vt towards right)**

From the above Figure **$x' = x - vt$** **(T1)**

The following figure depicts the scenario of the second event **E** from the perspective of the frame **S'**,

FIGURE 5

**Scenario of the Second Event from the perspective of Frame S'.
(O' at rest; O has moved the distance vt' towards left)**

From the above Figure $x = x' + vt'$

(T2)

Equations **(T1)** and **(T2)** represent the same reality from the perspectives of two referential frames. To satisfy the interchangeability of the frames, an essential requisite of the First Postulate of the Special Theory of Relativity, both equations must be mathematically identical. Since the object is to explain the constancy of the speed of light in all inertial frames, the Transformation Equations should include the scenario **when $x = ct$ (or) $-ct$, $x' = ct'$ (or) $-ct'$ respectively**. This requirement seems to demand **$t' \neq t$** . But, Equations **(T1)** and **(T2)** are not identical if **$t' \neq t$** . To make them identical, Lorentz Transformation includes a factor, say **α** , to the RHS of the two equations with a view to

derive an expression for **a** so as to make the Equations **(T1)** and **(T2)** identical. This factor **a** (named **γ** in many text books) is called **Lorentz Factor**.

With the inclusion of **Lorentz Factor (a)**, the Equations **(T1)** and **(T2)** become

$$\mathbf{x}' = \mathbf{a}(\mathbf{x} - \mathbf{v}t) \quad (\mathbf{T3})$$

$$\mathbf{x} = \mathbf{a}(\mathbf{x}' + \mathbf{v}t') \quad (\mathbf{T4})$$

When we rewrite the above Equations **(T3)** and **(T4)** in the following formats,

$$\mathbf{x} - \mathbf{x}'/\mathbf{a} = \mathbf{v}t \quad (\mathbf{T3a})$$

$$\mathbf{x}/\mathbf{a} - \mathbf{x}' = \mathbf{v}t' \quad (\mathbf{T4a})$$

The above Equations **(T3a)** and **(T4a)** indicate a significant consequence of the inclusion of **Lorentz Factor (a)**. It is **Length Contraction**. From the perspective of Frame **S**, the length measured by the Frame **S'** has contracted from **x'** to **x'/a**. Similarly, from the perspective of Frame **S'**, the length measured by the Frame **S** has contracted from **x** to **x/a**. This consequence of **Length Contraction**, in turn, has led to another more significant consequence of **Time Dilation**, which we shall discuss later.

Now, let us do the important task of finding a suitable expression for **Lorentz Factor (a)**, to make the Equations **(T3)** and **(T4)** identical so that the First Postulate of the Special Theory of Relativity is not violated.

Using the two values **p** and **q**, which we have already defined, we can rewrite Equations

(T3) and **(T4)** as follows:

$$\mathbf{qt'} = \mathbf{a(pt - vt)} = \mathbf{a(p - v)t} \quad (\mathbf{T3b})$$

$$\mathbf{pt = a(qt' + vt')} = \mathbf{a(q + v)t'} \quad (\mathbf{T4b})$$

$$\text{From } (\mathbf{3b}), \mathbf{t'/t = a (p - v) / q = ap(1 - v/p) / q} \quad (\mathbf{T3c})$$

$$\text{From } (\mathbf{4b}), \mathbf{t'/t = p / [a (q + v)] = p / [aq (1 + v/q)]} \quad (\mathbf{T4c})$$

From Equations **(T3c)** and **(T4c)**,

$$\frac{\mathbf{ap(1 - v/p)}}{\mathbf{q}} = \frac{\mathbf{p}}{\mathbf{aq (1 + v/q)}}$$

$$\mathbf{a^2 = 1 / (1 - v/p) (1 + v/q)}$$

$$\mathbf{a = \frac{1}{\sqrt{(1 - v/p) (1 + v/q)}}} \quad (\mathbf{T5})$$

The above **Equation (T5)** gives the general expression for **Lorentz Factor (a)**.

For a particular case where **p = q = ± c**,

$$\mathbf{a = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}}$$

Therefore, since Lorentz Transformation takes only the above particular value of **Lorentz Factor a**, it is applicable only to the pairs of events representing transmission of light with speed **c** in positive or negative direction and it cannot be applied to other pairs of events.

As regards the '**assumed**' scenario of an event of detection of Light at a spatial point in the **X-Y Plane** that does **Not** lie on the **X-Axis** depicted in **Figures (1) and (2)**,

$$\mathbf{p} = \mathbf{c} \cos \theta; \text{ and}$$

$$\mathbf{q} = \mathbf{c} \cos \Phi$$

Therefore, from the **Generalized Equation**, $\mathbf{a} = \frac{1}{\sqrt{(1 - v/p) (1 + v/q)}}$

We get the value of **Lorentz Factor**, $\mathbf{a}$ in this special case as follows:

$$\mathbf{a} = \frac{1}{\sqrt{(1 - v/c \cos \theta) (1 + v/c \cos \Phi)}}$$

Substituting the expression for $\mathbf{a}$ given by **Equation (T5)** in the Equations **(T3)** and **(T4)**, we get the **Generalized Transformation Equation for Space Difference** as follows:

$$\mathbf{x}' = (\mathbf{x} - \mathbf{vt}) / \sqrt{(1 - v/p) (1 + v/q)} \quad \textbf{(T3d)}$$

$$\mathbf{x} = \mathbf{a} (\mathbf{x}' + \mathbf{vt}') / \sqrt{(1 - v/p) (1 + v/q)} \quad \textbf{(T4d)}$$

The above Equations may be written in the following format **to make explicit the fact that the two Equations are identical**:

$$\mathbf{x}' = \frac{\sqrt{(1 - v/p)}}{\sqrt{1 + v/q}} \mathbf{x}$$

$$\mathbf{x} = \frac{\sqrt{(1 + v/q)}}{\sqrt{1 - v/p}} \mathbf{x}'$$

For the particular case $\mathbf{p} = \mathbf{q} = \pm \mathbf{c}$,

$$\mathbf{x}' = \frac{\sqrt{(1 - v/c)}}{\sqrt{1 + v/c}} \mathbf{x}$$

$$\mathbf{x} = \frac{\sqrt{(1 + v/c)}}{\sqrt{1 - v/c}} \mathbf{x}'$$

The above is the pure form Lorentz Transformation Equation for Space Difference.

The fact that the above Equations are identical is very much apparent on the face of them.

There is no intertwining of Space and Time.

We can derive the Generalized Lorentz Transformation Equation for Time Difference as follows:

$$\mathbf{t}' = \mathbf{x}' / \mathbf{q}$$

$$= \mathbf{a} (\mathbf{x} - \mathbf{vt}) / \mathbf{q}$$

$$= \mathbf{a} (\mathbf{pt} - \mathbf{vt}) / \mathbf{q}$$

$$= \mathbf{a}(\mathbf{p}/\mathbf{q}) (\mathbf{t} - \mathbf{vt}/\mathbf{p})$$

$$= \mathbf{a}(\mathbf{p}/\mathbf{q}) (\mathbf{t} - \mathbf{vx}/\mathbf{p}^2) \text{ since } \mathbf{t} = \mathbf{x}/\mathbf{p}$$

When $\mathbf{p} = \mathbf{q} = \mathbf{c}$.

$\mathbf{t}' = \mathbf{a} (\mathbf{t} - \mathbf{vx}/\mathbf{c}^2)$, which is the Lorentz Transformation Equation for Time Difference.

Similarly, it can be shown

$$t = \frac{1}{c} \left(\frac{q}{p} \right) (t' + vx'/q^2)$$

When $p = q = c$.

$t = \frac{1}{c} (t' + vx'/c^2)$, which is the Inverse Lorentz Transformation Equation for Time Difference.

Therefore, Lorentz Transformation is valid only **if $x' = ct'$ when $x = ct$.**

Thus, we have disproved in three ways Einstein's claim that the equation $\epsilon^2 + \eta^2 + \zeta^2 = c^2 \tau^2$ represents a spherical wave with velocity of propagation c when viewed in the moving system. In fact, the equation represents only a one-dimensional wave propagating in the direction of the relative velocity between the two systems.

It is relevant to note that Einstein's derivation of Lorentz Transformation Equations itself was regarding a ray of light transmitted along the X-axis. **"From the origin of system k let a ray be emitted at the time τ_0 along the X-axis to x' ," [2].** His assumption in a later part of his paper that Lorentz Transformation Equations so derived by him were valid even for the events of the light wave reaching the spatial points not lying on the X-axis has been proved to be wrong in the above-detailed discussion.

PART – II

Moving clocks run slow?

2.2.1 “Moving Clocks run slow” is not at all a prediction of Lorentz Transformation.

Lorentz Transformation compares the space and time intervals between two events measured in one inertial frame with those measured in another frame. If $t' < t$, it does not mean that the clock in the primed frame run slower than the one in the unprimed frame. The perfect functioning of the measuring tools is a basic premise of any Transformation, Lorentz Transformation not excluded. That $t' < t$ only means that the time interval between the two events measured in the primed frame is shorter than that measured in the unprimed frame.

In the following discussion, we shall follow the convention of defining an event by (x, t) where x and t refer to space and time coordinate of the event. When Lorentz Transformation is applied to two events, it is usual, for the simplicity of mathematical operations, to define the first event as $(0, 0)$ in both frames and the second event by (x, t) in one frame, say S , and (x', t') in the other frame, say S' , so that x and x' give the space difference and t and t' the time difference between the two events in the frames S and S' respectively.

If an instant of time is shown as t by one clock, and the same instant of time as t' by another clock and $t' < t$, then we can say that the second clock runs slower than the first

clock. But, when t' is really an earlier instant of time shown by that clock at that instant of time, it does not mean that the clock runs slow.

In this section we are going to prove in three methods that when Lorentz Transformation says $t \neq t'$, it does not mean that the moving clock runs slower than the stationary clock and it only means that t and t' are two different instants in the Absolute Time Chain.

2.2.2 FIRST METHOD - MUTUAL LENGTH CONTRACTION

When Jill is shorter than Jack, it means Jack is taller than Jill. But, according to Lorentz Transformation, when two rods of equal length are in motion with a uniform, linear, relative velocity between them, an observer on one rod would find the other rod shorter than his rod, and vice versa. Lorentz Transformation makes this seemingly impossible feat possible only because of its stand that when the time instant of happening of an event is t in one frame and t' in another frame, t and t' do not denote one single moment, but they are two different instants in the Absolute Time Chain

Let two rods, say **AB** and **A'B'** of equal length **L**, while both are at rest, are in motion with a uniform, linear, relative velocity, say **v**. When the ends **A** and **A'** coincide, let the observers set the clocks at those ends to read **0**.

FIGURE 6
From the viewpoint of S, at the instant when all its clocks show an identical time of 0

We can see from the above diagram that the length **A'B'** is measured to be **L/a** by the observer **S**. But, the above measurement of the length of **A'B'** as **L/a** by **S** would not be agreeable to **S'** for the reason that **S** noted the ruler mark of the end **B'** at the instant, $-vL/c^2$ and later the ruler mark of the end **A'** at the instant **0**. It means at a time instant earlier to the origin time instant of **0** by vL/c^2 , the ruler-mark **L/a** of the rod **AB** coincided with the ruler-mark **L** of the rod **A'B'**.

From the perspective of the rod A'B':

The rod **AB** is moving towards the right with the velocity **v** and hence during the time interval between $-vL/c^2$ and **0**, the rod **AB** would have covered a distance v^2L/c^2 and because of Length Contraction, this distance as measured in the system **AB** would be av^2L/c^2 . Thus, during the time interval between $-vL/c^2$ and **0**, the rod **AB** would shift towards left through a distance av^2L/c^2 , and when the time is **0**, the ruler-mark of **AB** that would be coinciding with the ruler-mark **L** of **A'B'** would be

$$= L/a + av^2L/c^2$$

$$= L/a (1 + a^2v^2/c^2)$$

$$= L/a [1 + (c^2 / (c^2 - v^2)) v^2/c^2]$$

$$= L/a [1 + (v^2 / (c^2 - v^2))]$$

$$= L/a [c^2 / (c^2 - v^2)]$$

$$= La^2/a$$

$$= aL$$

Therefore, from the perspective of the system **A'B'**, at the origin instant when the time was **0**, its ruler-mark **L** coincided with the ruler mark **aL** of the rod **AB**. Hence the rod **AB** is shorter than the rod **A'B'**.

FIGURE 7
From the viewpoint of S', at the instant when all its clocks show an identical time of 0

From the above discussion, it is clear that the event of the ruler-mark **L/a** of the rod **AB** coinciding with the ruler-mark **L** of the rod **A'B'**, happened at the time instant **0**

for the system **AB**, the same **Event** happened at an instant earlier by $\mathbf{vL/c^2}$ for the system **A'B'**.

So, generally, when the time instant of happening of an event is **t** in one frame and **t'** in another frame, **t** and **t'** do not denote one single instant of time, but they are two different instants in the Absolute Time Chain

[It is relevant to note that the happening of the **event of the ruler-mark L/a of the rod AB** coinciding with the ruler-mark **L** of the rod **A'B'** was not denied by either the observers of the system **AB** or the observers of the system **A'B'**. They differ only on when and where that event happened. It means that Events are absolute and only the space differences among them are relative according to Galileo Transformation and both space and time differences are relative according to Lorentz Transformation.]

2.2.3 SECOND METHOD – RELATIVITY OF SIMULTANITY

Let a light wave start spreading from the midpoint **M'** of a moving train **A'B'** of length **2L**. Let the clock attached to the train at the point **M'** and the clock attached to the platform at the point **M** be set to read **zero** at the instant when **M** and **M'** coincide. Let the point of coincidence of **M** and **M'** be taken as the origin point.

Obviously, the light wave would reach the two ends **A'** and **B'** simultaneously in the train frame. But, according to Lorentz Transformation, from the viewpoint of a stationary observer on the platform, the light wave would reach the two ends at two different instants of time.

FIGURE 8

Let us call the event of the light wave reaching the end **A'** of the train **Event – A**.

Let us call the event of the light wave reaching the end **B'** of the train **Event – B**.

The time of occurrence of the **Event – A** is (L/c) in the Train Frame and $(aL/c-avL/c^2)$ in the Platform Frame. The question is whether (L/c) in the Train Frame and $(aL/c-avL/c^2)$ in the Platform Frame refer to one and the same instant of time.

Similarly, the time of occurrence of the **Event – B** is (L/c) in the Train Frame and $(aL/c + avL/c^2)$ in the Platform Frame. The question is whether (L/c) in the Train Frame and $(aL/c + avL/c^2)$ in the Platform Frame refer to one and the same instant of time.

If they are just different labels attached to the same instant of time, that would mean that the Event – A and Event – B are simultaneous for the Platform Frame. But, according to Lorentz Transformation, they are not simultaneous in the Platform Frame. Therefore, the time of the happening of the event in the Platform Frame is either earlier or later than the time of happening of the same event in the Train Frame. This is the correct interpretation of the Relativity of Time propounded by Lorentz Transformation.

When an event is defined as (x, t) by the frame S , and (x', t') by the frame S' , it does not mean that t and t' denote the same instant of time; it means that the event happens at the instant t from the perspective of S and the same event happens at the instant t' from the standpoint of S' . t and t' are two different instants among the infinite time instants constituting the Time chain.

An event is absolute in the sense that the observers in all inertial frames would agree that it has happened, but they differ on only when it happened. If t and t' were only different labels of the same instant of time, then Einstein's claim that "**Simultaneity is relative**" would be meaningless.

2.2.4 THIRD METHOD – LENGTH CONTRACTION

Let **A** and **B** be two points on Earth with a distance **D** between them. From the perspective of any stationary observer on Earth, a particle, say **P**, moving with a velocity of **v** would move from **A** to **B** in **D/v** seconds. The time of travel **t = D/v**

FIGURE 9
INITIAL SCENARIO (From the perspective of Earth Frame)

FIGURE 10
INITIAL SCENARIO (From the perspective of P Frame)

Since the **Earth Frame** is the moving frame from the perspective of **P Frame**, the distance **D** between the points **A** and **B** on Earth would be a shortened distance **D/a** for that frame. Therefore, from the perspective of **P Frame**, the shortened distance **D/a**

will be covered by the particle **P**, moving with a velocity of **v** in **D/av** seconds. The time of travel **t' = D/av**

Therefore **t' < t** was not due to the moving clock going slow, but it was because the distance was covered in a shorter time from the perspective of the frame of the particle that covered the distance.

When a super speed aircraft flies with a speed **v**, which is nearer to the speed of light, the distance between the two cities London and Paris, is **x** for the observers on the earth, and it is **x/a** for the pilot of the aircraft. If the earth observers and the pilot of the aircraft flying towards Paris set their clocks to zero at the instance of the aircraft crossing London, the aircraft would cover the distance **x/a** between London and Paris in **x/av** seconds. When the time shown by all clocks of the earth and aircraft was **x/av**, the aircraft pilot would see the aircraft crossing Paris at that time, and for the earth observers, the aircraft was yet to cross Paris. When the time shown by all clocks was **x/v** second, the earth observers would see the aircraft crossing Paris at that time; but for the pilot of the aircraft, there was no crossing Paris at that instant because it had already crossed that city. This is what Lorentz Transformation predicts.

The same event happening at different times for different inertial frames would be the correct interpretation of Lorentz Transformation if it were true. The same events occur in the same sequence for all inertial frames, but different frames would assign different time values to those events, if Lorentz Transformation were true.

2.2.5 The same event recurs infinite times

When a specific event is represented by **(X, T)** in the frame **S**, for that frame, it had happened when the Time was **T**. For any other frame moving with a velocity **v** relative to it, the same event has occurred at the time **t'** given by the following expression.

$$t' = \frac{T - vX/c^2}{\sqrt{1 - v^2/c^2}}$$

Since the value of **v** is different for different frames, it varies between **- ∞** to **+ ∞**. So, the event repeats infinite times –one instance for each inertial frame.

According to Lorentz Transformation, every event in the universe happens at different times for different inertial frames, which implies that the same event recurs infinite times.

The following Graph depicts how simultaneous events observed in one frame are not simultaneous in another frame.

The simultaneous events happening at different instants of time in the perspective of an inertial frame of reference along the X-axis have been shown as horizontal lines in the graph. Each horizontal line corresponds to a line inclined at the angle **$\tan^{-1} (-av/c^2)$** to it give the time instants of those events (not simultaneous but spread over an infinite spectrum) from the perspective of another inertial frames.

FIGURE 11
Simultaneous Events for one Frame spread over an infinite spectrum for another Frame

$$\tan \theta = -av/c^2$$

$$t' = x \tan \theta + at$$

The simultaneous events happening in the entire universe at an instant of time **t** relative to an observer in any inertial frame spread over an infinite time spectrum for the observers in all other frames.

2.2.6 The observed slowing down of moving clocks may be due to Relativistic Variations of mass with velocity and gravity with altitude.

The observed slowing down of clocks moving with a high-speed relative to the Earth has to be traced to some reason other than Lorentz Transformation. It may be examined whether it is due to the period of oscillation of the clock getting changed on account of

the relativistic variation of the mass of the clock with its velocity or the variation of gravity with altitude.

$$\mathbf{m} = \mathbf{m}_0 / (1 - \mathbf{u}^2/\mathbf{c}^2)^{1/2}$$

The variation of gravity with altitude may also contribute to slowing down clocks moving at high altitudes. The above possibilities deserve a thorough examination because **"The oscillation frequencies within the atom are determined by the mass of the nucleus and the gravity and electrostatic "spring" between the positive charge on the nucleus and the electron cloud surrounding it." [4]**

PART – III

An explanation for the constancy of the Speed of Light in all inertial frames, based on Perceptual Relativity

3.1 Basic Premises

The following two premises underline the whole gamut of Physics.

1. The Laws of Physics have been discovered and derived from an observer's perspective while that observer rests in an inertial frame of reference.
2. Space is at rest relative to the observer's Frame of reference, and all other inertial frames are moving in that Space.

The second premise ensures the certainty of measurements of the distances in Space travelled by the moving objects, which is not guaranteed when Space also is moving relative to the observer.

3.2 Space is stationary in every Frame.

Space is static in his Frame for any observer, and the other frames move in that Space. Just like there is a common perception of the stationary observers in every Frame that their Frame alone is at rest while all other frames are moving, those observers share another common perception that Space is at rest in their Frame. Since an observer observes that the objects attached to his Frame are at rest and Space is static, he assumes that Space is also linked to his reference frame. This perception implies that any Point in Space can be claimed to be attached to his Frame of reference by any observer regardless of his motion relative to other observers.

Let an observer stationed in an inertial frame, say **S**, places a minuscule material marker **p** at a spatial point to identify that point. An observer stationed in another inertial frame, say **S'**, which moves at a speed **v m/s** relative to the frame **S**, also places a minuscule material marker **q** at another spatial point to identify that point. Let the distance between the markers **p** and **q** be **v meters** at one instant of time. After **1 second**, the two markers would collide. That spatial point of the happening of the event of collision would be the point **p** from the perspective of the observers of the frame **S**; it would be the point **q** from the perspective of the observers of the frame **S'**.

FIGURE 12

The spatial point where the event occurred

Initial scenario

Final scenario from the perspective of the frame S

Final scenario from the perspective of the frame S'

The event of collision of particles **p** and **q** cannot be said to have happened at any particular point in absolute space. For the observers of each frame, the event occurred at a point in Space attached to their frame. As there are infinite inertial frames of reference, a single event has happened at infinite points in space – each point corresponding to one of the frames.

It may be that there are infinite Spaces – each one belonging to one Inertial Frame, or one single Space perceived as being static in his Frame by every observer.

Einstein did not rule out the possibility of an infinite number of Spaces in motion relative to each other. It is evident from the following extract from the book "**Relativity – The Special and the General Theory**," written by him. (Fifteenth Edition Appendix 5 "Relativity and the Problem of Space" –Pigeon - First Indian Edition 2008 – Page 145

[2]):

*"But it must now be remembered that **there is an infinite number of spaces, which are in motion with respect to each other.** The concept of Space as something existing objectively and independent of things belongs to pre-scientific thought, but not so the idea of an infinite number of spaces in motion relatively to each other. This latter idea is indeed logically unavoidable but is far from having played a considerable role even in scientific thought."* (Emphasis supplied).

3.3 For any observer, any Light source is at rest in his Frame alone.

Now, let us consider a point anywhere in the entire Space from which Light originates. The spatial location of the Light emitter is the point in Space from where the Light originates. The emitter's speed is immaterial since it is a verified fact that the speed of the emitter is not passed on to the Emitted Light, and hence the Speed of Light is independent of the speed of the emitter. The spatial location of the emitter is, instantaneously, the point in Space from where Light emanates. An observer intending to measure Light's speed has to place a material marker, say **●**, at the Light-Emitter's spatial location to fix Light's starting point. Obviously, that marker will remain stationary in his Frame. An observer in another frame of reference can also place another marker, say **●'**, at the same point, and that marker will remain stationary in that Frame. There will undoubtedly be relative displacement between the two markers after that instant of time. Still, each observer will assume that his marker has remained at the Same point in Space while the other marker has been moving. Thus, every observer can claim that the light source is stationary in and attached to his Frame.

3.4 An observer detects Light using a Light Detector that is at rest in his Frame alone.

Any Light Detector, any material object for that matter, is at rest in only one inertial Frame, and it is moving relative to all other frames. The clock of that Light Detector is synchronized with the other clocks attached to its Frame. For any particular instant of time, all the clocks attached to his Frame would show an identical time, whereas, if Lorentz Transformation were true, the clocks attached to any other frame would appear to be non-synchronized, each clock living in a different instant of time. This scenario implies that for measuring the Speed of Light in his Frame, the observer has to use the Light Detector attached to his Frame to ensure recording of correct durations of time according to his Frame. Let alone Lorentz Transformation. since every observer perceives that the light source is stationary in and attached to his Frame (as has been discussed in the previous paragraph), the Light Detector attached to his Frame at a constant distance, say x meters, from the Light Source, would receive the Light signal that had originated from the Light Source x/c seconds before such detection. Since any Light Detector cannot detect any Light Signal that approaches it with speed relating to it being not equal c in violation of the Principle of Constancy of the Speed of Light, it would detect only the Light Signals originating from the Light Sources attached to its Frame. This reality means that the material marker representing the Light Source's spatial point is at rest relative to the Light Detector.

In fine, for any detection of Light by any observer, he has to ensure that both the Light Source and the Light Detector are attached to his Frame of Reference.

3.5 For any observer, Light spreads in his Frame alone.

There is an infinite number of inertial frames of reference – each Frame moving with a non-zero velocity relative to any other frame. When a spherical electromagnetic wave propagates with a speed **c** from a Space point in all directions, it spreads in each of the infinite inertial frames of reference. But, for an observer in any one of those frames, his perceived facts are the following:

- 1. The spatial point from which the light wave has started propagating is stationary in and attached to his Frame (i.e., Space itself is attached to his Frame);**
- 2. The light wave propagates in the Space which is attached to his Frame; and**
- 3. His detection of Light Signals is confined to those originating from Light Sources attached to his Frame and reaching the Light Detectors attached to his Frame. The light waves propagating in 'spaces' of other frames, if any, are beyond his perception and hence of no concern to him.**

Suppose the velocity of a moving material particle (i.e., a particle having mass) relative to a frame of reference is known. In that case, to calculate the particle's velocity relative to another frame of reference, we have to use the **Law of Addition of Velocities**. But, in the case of transmission of Light, for any observer, Light spreads only in his Frame, and he is immune from the perception of or any impact from Light Waves, if any, spreading in other frames and hence there is no question of calculating the speed of Light in any different frame relative to him. **Accordingly, the Law of Addition of velocities has no relevance to the Speed of Light.**

3.6 Correct Explanation for Light Speed's Constancy

Let us visualize two rectangular slabs, **S** and **S'**, resembling Light Clocks with one end fitted with the Light Sources **O** and **O'** and the other end with Light Detectors **D** and **D'** respectively. Let both slabs be of an identical length, say **L**. Let the two slabs rest relative to one another. When the Light travels from the Source to the Detector, it spans the same distance **L** during the same time interval **L/c** in both slabs (**c** is the universal constant of the speed of Light for any observer.)

Let the two frames be set in a relatively uniform linear motion along the horizontal axis with a constant relative velocity equal to **v** m/s. Now, the two slabs **S** and **S'** constitute two different inertial frames of reference. The stationary observers in each Frame perceive that their Frame continues to be in the same state of rest, and only the other frame has started moving. From each Frame's stationary observers' perspective, nothing has changed as far as their Frame is concerned, and Light covers the same length **L** of their Slab in the same **L/c** seconds.

Let a Light pulse starts from the Light Source **O** and the Light Source **O'** simultaneously when the instant of time is counted as **0** in both frames **S** and **S'**.

The scenarios from the viewpoint of **S** and **S'** starting from this instant have been depicted below.

- (i) **At the instant when a Light Signal originates**

FIGURE 13
Light originates from a Light Source.

- (a) From the perspective of the Frame S

FIGURE 14
Light reaches the Light Detector attached to Frame S.

- (1) The Light Signal originated from the Light Source **O** when **t = 0**, is detected by the Light Detector **D**.
- (2) While their Frame has been remaining at rest occupying the same part of the **Space**, the Slab of the other frame **S'** has moved in the Space towards the right through a distance **vt** and occupied a different part of the Space.

They cannot make any observation regarding detection of Light by the Light Detector **D'** attached to a different frame. Any Light Detector attached to the other frame **S'** cannot detect Light originating from Light Source **O** not attached to that Frame.

(b) From the perspective of Frame S'

FIGURE 15
Light reaches the Light Detector attached to Frame S'.

The stationary observers of the Frame **S'** make the following observations, -

- (1) The Light Signal originated from the Light Source **O'** when **t = 0**, is detected by the Light Detector **D'**.
- (2) While their Frame has been remaining at rest, occupying the same part of the **Space**, the Slab of the other Frame **S** has moved in the Space towards left through a distance **vt** and occupied a different part of the Space.

They cannot observe the detection of Light by the Light Detector **D** attached to a different frame. Any Light Detector attached to the other frame **S** cannot detect Light originating from Light Source **O'** not attached to that Frame.

For the static observers in both frames **S** and **S'**, the Light covered the distance **L** during the time interval **t** so that the speed of Light is **L/t**, i.e., **c**. Regardless of relative displacements between Light Sources **O** and **O'** and between Light Detectors **D** and **D'**, both observers would measure Light's Speed to be **c**.

Any Light Detector can detect Light originating from a light source that is at rest in the same Frame in which it is also at rest. It follows that no static observer in an inertial frame detects Light that has originated from a Light Source that is not at rest relative to his Frame. To make this fact amply clear, we may adopt the following statement as the **Third Postulate of the Special Theory of Relativity (STR)** in place of **Lorentz Transformation**, a suggestion given by this author in an earlier paper under the title **“An implicit and untested premises of the Special Theory of Relativity” [5]**

"The detection of light by an inertial reference frame is an event that is exclusive to that frame."

The above statement implies that the Speed of Light relative to any inertial reference frame cannot be measured by any observer who is not stationary in that Frame. **The Constancy of the Speed of Light measured in all frames of references is due to each observer's perceptions that Space is at rest relative to his Frame of Reference, and the light source and the light Detector are static in his Frame of reference.**

Space is the medium for the transmission of electromagnetic waves. The speed of the propagation of electromagnetic waves relative to Space is **c**, a constant. Since Space is at rest in any inertial frame of reference, the speed of the transmission of electromagnetic waves relative to any inertial frame of reference is also **c**. Thus, we have derived a precise explanation for the Speed of Light's constancy measured in all frames of references without 'torturing' the observers' measuring rods and clocks.

PART – IV

Mass – Energy Equivalence

Suppose the mass of a particle when it is at rest in an inertial frame is **m₀**. Let its relativistic mass be **m**, while it is moving with speed **v** relative to that Frame. We know

[6] -

$$\mathbf{m = m_0 / (1 - v^2/c^2)^{1/2}}$$

Generally, the above equation is derived using Lorentz Transformation Equations. But the above equation can be arrived at without the use of Lorentz Transformation Equations based on the following observed facts, -

1. It has been experimentally proved that no particle can travel faster than c , the Speed of Light. When a particle's speed is accelerated to a value near c , the inertial mass m that resists acceleration tends to become ∞ , thereby making it impossible to make the particle reach Light's speed.
2. The above equation corresponds to the fact that when an external force acts on a particle with rest mass m_0 in an inertial frame and increases its velocity by v , then the particle can be viewed as

(Either)

having a rest mass energy $m_0 c^2$ plus kinetic energy slightly higher than $m_0 v^2 / 2$ from the perspective of the original inertial frame

(Or)

having a rest mass energy mc^2 and being at rest from the perspective of the inertial frame moving with a velocity v relative to the original frame.

$$\begin{aligned}
 m &= m_0 / (1 - v^2/c^2)^{1/2} \\
 &= m_0 (1 - v^2/c^2)^{-1/2} \\
 &= m_0 (1 + (1/2) v^2/c^2) \quad \text{when } v \ll c.
 \end{aligned}$$

$$mc^2 = m_0 c^2 + m_0 v^2 / 2$$

As already said, the observed slowing down of clocks moving with a high-speed relative to the Earth in **Hafele–Keating experiment** may be due to the variation of the mass of the clock with its velocity.

It has been shown in many textbooks **[7]** on Special Theory of Relativity that from the above equation giving a variation of mass with velocity, the following famous **mass-energy equivalence** equation can be derived;

$$\mathbf{E = mc^2}$$

Thus, Mass-Energy Equivalence can be derived without Lorentz Transformation,

Section 3: Conclusions

- 1.** The Constancy of the Speed of Light measured in all frames of references is due to each observer's perceptions that Space is at rest relative to his Frame of Reference, the Light Source is static in his Frame of Reference, the Light originating from that stationary Source spreads as a spherical electromagnetic wave in all directions with a speed **c** in his static Space; and the Light so spreading is capable of being detected only by any Light Detector that is stationary in the Frame.
- 2.** The detection of Light by an inertial reference frame is an event that is exclusive to that Frame.
- 3.** Lorentz Transformation is conceptually flawed.
- 4.** Time is absolute. There is no Interdependence of Space and Time.

5. The results obtained in the **Hafele–Keating experiment** and **μ meson experiment** do not support the predictions of the Lorentz Transformation.
6. The Mass – Energy equivalence **$E = mc^2$** can be derived without Lorentz Transformation.

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